Highly selective filtering device and corresponding filtering method

DESCRIPTION

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The invention relates to a highly selective filtering device for use particularly in transmission systems, and also to the filtering method used.

10 Transmission systems use very many types of filters. By way of example, Figure 1 shows an example of an external unit 1 connected between an antenna 2 and an internal unit (not shown) such as a satellite decoder with a return channel or a decoder for a high-speed

15 point-multipoint transmission system. The external unit 1 is of a type which requires high precision in its local oscillator 9, as described for example in U.S. Patent 5,844,939. Two bandpass filters 3 and 4 are used to separate the transmission and reception bands. Two

20 other bandpass filters 5 and 6 are used to separate the intermediate transmission and reception bands. Two mixers 7 and 8 and an oscillator 9 carry out frequency transpositions between the transmission and reception bands and the intermediate transmission and reception

25 bands. To provide high precision in the frequency of the oscillator 9, the latter is locked to a reference carrier with a highly stable frequency by means of a phase-locked loop which additionally comprises a filter 10 which selects the intermediate band reference

30 carrier, a phase comparator 11 and a precise reference oscillator 12. A person skilled in the art can find further details of this external unit in U.S. Patent 5,844,939.

35 An advantage of this system is that the oscillator 9 is synchronized with the oscillator of a base station, making it possible to obtain a high relative precision between the transmission and reception frequencies. However, with this type of locking, the phase noise of

- 2 -

the oscillator 9 depends on the pass band of the filter
10. If a very low phase noise is desired, it is
necessary to have a highly selective filter.

5   The highly selective filters which are known to have
been used include quartz filters consisting of coupled
resonators which have a high quality coefficient, of
the order of 10,000 to 50,000 for example. An example
of a frequency response of a quartz filter is shown in
10   Figure 2. Quartz filters have a narrow band B of the
order of ten kHz for a central frequency Fc of the
order of 100 MHz, while having very good temperature
resistance.

15   However, quartz filters have an asymmetrical frequency
response. The low frequency rejection is very good. For
high frequencies, however, the rejection is degraded by
parasitic resonances 15. These parasitic resonances
depend on the geometry and cross section of the quartz
20   used in the filter and are very difficult to control
during the manufacture of the filters.

One object of the invention is to provide a filtering
device having a frequency response which is
25   symmetrical, while retaining the advantages of an
asymmetric bandpass filter such as a quartz filter.

The invention is therefore a filtering device having a
first bandpass filter with a given central frequency
and a given bandwidth, a second bandpass filter
30   identical to the first bandpass filter, and frequency
transposition means, connected between the first filter
and the second filter, which transpose the central
frequency of the first filter to the same central
35   frequency while inverting the spectrum around the
central frequency.

Preferably, the transposition means comprise a mixer
having two inputs and one output, one of the inputs

- 3 -

being connected to an output of the first bandpass
filter and the output being connected to an input of
the second bandpass filter, and an oscillator having an
output connected to the other input of the mixer, the
5   oscillator supplying a signal at a frequency equal to
twice the central frequency of the first and second
bandpass filters.

To provide a filtering device with a very narrow band,
10 the first and second filters are quartz filters.

The invention is also an external unit of a signal
transmission and reception device, comprising an
adjustable oscillator, which is locked to a received
15 carrier frequency, and a filtering device as defined
above which is connected in the locking loop of the
adjustable oscillator.

In another aspect, the invention is a method for the
20 selective filtering of a signal in which a first
selective filtering is carried out in a given frequency
band, the said band having a central frequency, by
means of a first asymmetric filter, to provide a first
filtered signal; the first filtered signal is
25 transposed to place an image corresponding to the given
frequency band in the same band but with an inverted
spectrum with respect to the central frequency; and a
second selective filtering is carried out in the given
frequency band, by means of a second asymmetric filter,
30 to provide a second filtered signal, the second filter
being identical to the first filter.

Preferably, the transposition is carried out by a mixer
which receives a transposition signal whose frequency
35 is twice the central frequency of the filters.

The invention will be more clearly understood and other
characteristics and advantages will become evident when
the following description is read, this description

- 4 -

making reference to the attached drawings, in which:

Figure 1 shows an external unit of a transmission and
reception device using an oscillator locked to a
5   received carrier frequency,
Figure 2 shows a response curve of a quartz filter,
Figure 3 shows a filtering device according to the
invention,
Figure 4 shows the operation of the filtering device of
10   Figure 3.

Since Figures 1 and 2 have been described already, they
will not be described in greater detail.

15   In order to improve the external unit of Figure 1, the
use of a filtering device 10 as illustrated in Figure 3
is proposed. The filtering device 10 comprises a first
filter 21 and a second filter 22 interconnected by
frequency transposition means. The first and second
20   filters are bandpass filters whose frequency response
is asymmetrical. To obtain a highly selective filtering
device, the first and second filters are quartz filters
whose frequency response corresponds to that shown in
Figure 2, each filter having a pass band B centred on a
25   central frequency Fc. The input of the first filter 21
corresponds to the input of the filtering device 10 and
the output of the second filter 22 corresponds to the
output of the filtering device 10.

30   The transposition means comprise a mixer 23 and an
oscillator 24. A first input of the mixer 23 is
connected to the output of the first filter 21. A
second input of the mixer 23 is connected to an output
of the oscillator 24. An output of the mixer 23 is
35   connected to the input of the second filter 22. The
oscillator 24 supplies at its output a signal whose
frequency is equal to twice the central frequency Fc.

The operation of the filtering device 10 of Figure 3

- 5 -

will now be explained with reference to Figure 4. We
shall assume that the input signal Si of the filtering
device is a white noise whose frequency spectrum is
equal to a constant, regardless of the frequency. At
5   the output of the first filter 21, the resulting signal
S1 corresponds to the envelope of the first filter 21,
as shown in Figure 4a. Figure 4a shows in a schematic
and less detailed way the same envelope as Figure 2.

10   Figure 4b shows the signal S2 corresponding to the
output of the mixer 23. The oscillator 24 supplies a
signal equal to twice the frequency Fc. A radiation
line 30 corresponding to this oscillator frequency is
present and corresponds to a leak from the mixer 23. A
15   first image 31 of rank 1 is present, with an inverted
spectrum around the frequency Fc. A second image 32 of
rank 1 is present around the frequency 3*Fc. A third
image 33 of rank 2 is also present with an inverted
spectrum around the frequency 3*Fc. Other images, not
20   shown, are also present at frequencies which are odd-
numbered multiples of the frequency Fc, with different
attenuations, depending on the rank of the image, as
will be familiar to those skilled in the art. A
residual image 34 is also present around the frequency
25   Fc. However, the residual image 34 corresponds to an
isolation fault of the mixer 23 between the input of
the signal for transposition and its output. As is
known by those skilled in the art, many mixers have an
isolation of the order of 40 dB between the input and
30   output of the signal, making the residual image
negligible with respect to the first image 31 of rank
1.

Figure 4c shows the superimposition of the first image
35   31 on the envelope 35 of the second filter 22, showing
how they are positioned with respect to each other.

Figure 4d shows the output signal So corresponding to
the signal leaving the second filter 22. Since the

- 6 -

input signal Si is a white noise, the signal So also corresponds to the envelope of the filtering device 10. As Figure 4d shows, the pass band is very narrow and symmetrical. There are still some parasitic resonances
5   36, but these are greatly attenuated and no longer create significant undesirable perturbation.

A person skilled in the art will understand that a filtering device of this kind can be adapted to any
10 type of filter having an asymmetrical frequency response, and is not limited to quartz filters.

Different transposition means can also be used. The preferred example shows a simple arrangement which
15 requires the use of a mixer with low leakage. However, it is possible to use other transposition means, for example by combining two mixers in order to reduce the constraints on mixer leakage.